

Multimedia Systems

Lecture – 23

By

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Huffman Coding

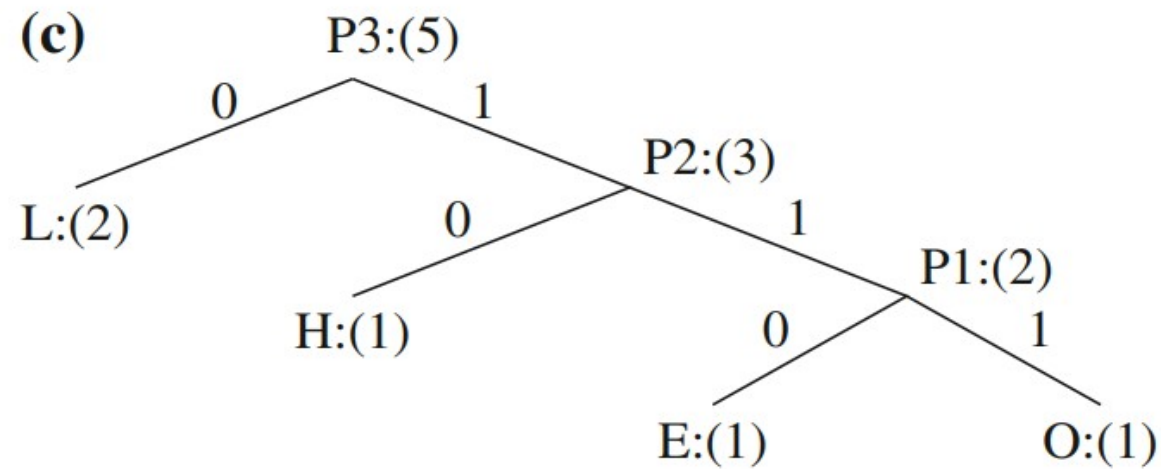
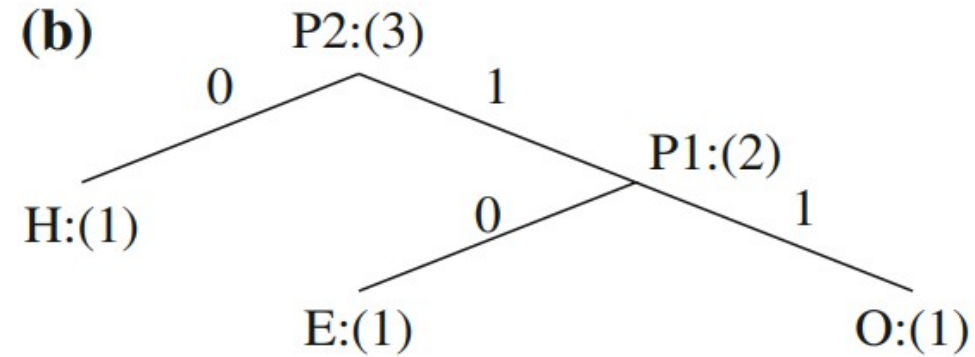
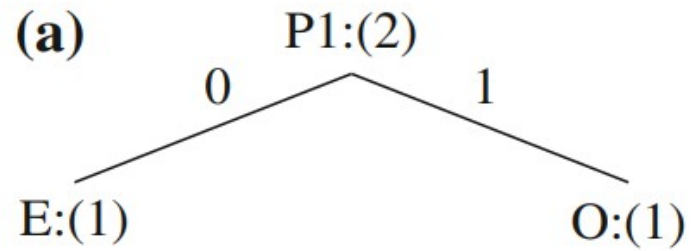
- First presented by Huffman in a 1952.
- This method attracted an overwhelming amount of research and has been adopted in many important and/or commercial applications, such as fax machines, JPEG, and MPEG.
- In contradistinction to Shannon–Fano, which is top-down, the encoding steps of the Huffman algorithm is a bottom-up approach.
- Let us use the same example word, HELLO. A similar binary coding tree will be used as above, in which the left branches are coded 0 and right branches 1. A simple list data structure is also used.

Huffman Coding Algorithm

Algorithm 7.1 (Huffman Coding).

1. Initialization: put all symbols on the list sorted according to their frequency counts.
2. Repeat until the list has only one symbol left.
 - (a) From the list, pick two symbols with the lowest frequency counts. Form a Huffman subtree that has these two symbols as child nodes and create a parent node for them.
 - (b) Assign the sum of the children's frequency counts to the parent and insert it into the list, such that the order is maintained.
 - (c) Delete the children from the list.
3. Assign a codeword for each leaf based on the path from the root.

Coding tree for HELLO using the Huffman algorithm. a First iteration; b Second iteration; c Third iteration



- symbols P1, P2, P3 are created to refer to the parent nodes in the Huffman coding tree.
- The contents in the list are illustrated below:
 - After initialization: L H E O
 - After iteration (a): L P1 H
 - After iteration (b): L P2
 - After iteration (c): P3
- The average number of bits used to code each character is also 2, (i.e., $(1 + 1 + 2 + 3 + 3)/5 = 2$).
- **Example-2:** Consider a text string containing a set of characters and their frequency counts as follows: A:(15), B:(7), C:(6), D:(6) and E:(5). Find out the number of bits required in case of Shanon-Fano and Huffman Coding.

